



Decontamination of Chemical Contaminants from Sub-Zero to Hot Temperatures

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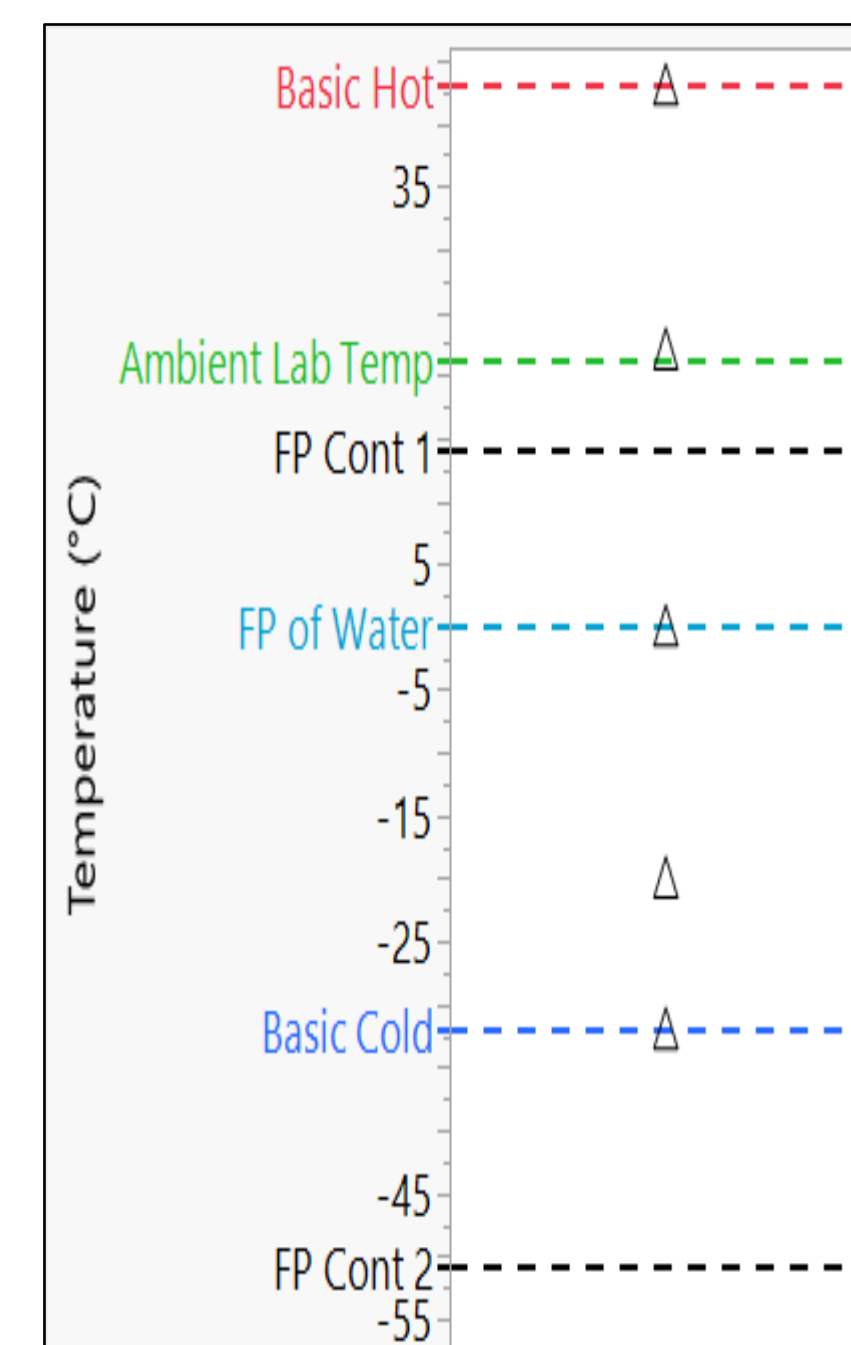
ABSTRACT

Laboratory evaluations of decontaminant performance are typically performed in well-controlled ambient environments to provide confidence in results. Different temperature environments may alter the effectiveness of a decontaminant, depending upon its composition. Aqueous decontaminant formulations may be subject to freezing, which limits applicability and interaction with contaminants. Whereas elevated temperatures may increase the rate of reaction for decontaminants with the contaminants, increasing their efficacy.

The Decontamination Sciences Branch at DEVCOM CBC has developed the capability to perform decontaminant evaluations inside a temperature-controlled enclosure, capable of producing an environments between -40°C and 50°C. The enclosure also meets safety standards for work with neat chemical contaminants.

The efficacy of the Decon Slurry, originally developed at DEVCOM CBC, was evaluated against two contaminants over a range of temperatures from -32°C to 43°C, using pipette application on coatings for decontamination times of 30 min and 4 hr. The results show that the decontaminant remains as a liquid and can be applied at temperatures as low as -32°C, while still providing decontaminant performance. These studies also show that the formulation can be used in arctic environments, where aqueous-based decontaminants would not be able to be applied due to the freezing point of water.

THE EFFECT OF TEMPERATURE EXTREMES



△ Test performed

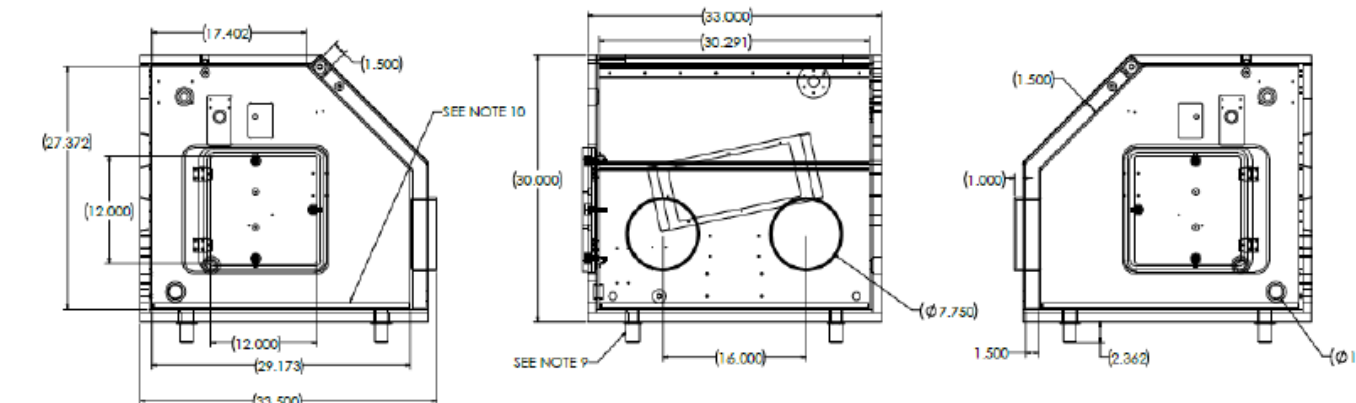
As Temperature increases: ↑

- The rate of detoxification increases
- Decon works better
- Absorption of the contaminants into substrate increases
- Decon less effective

As Temperature decreases: ↓

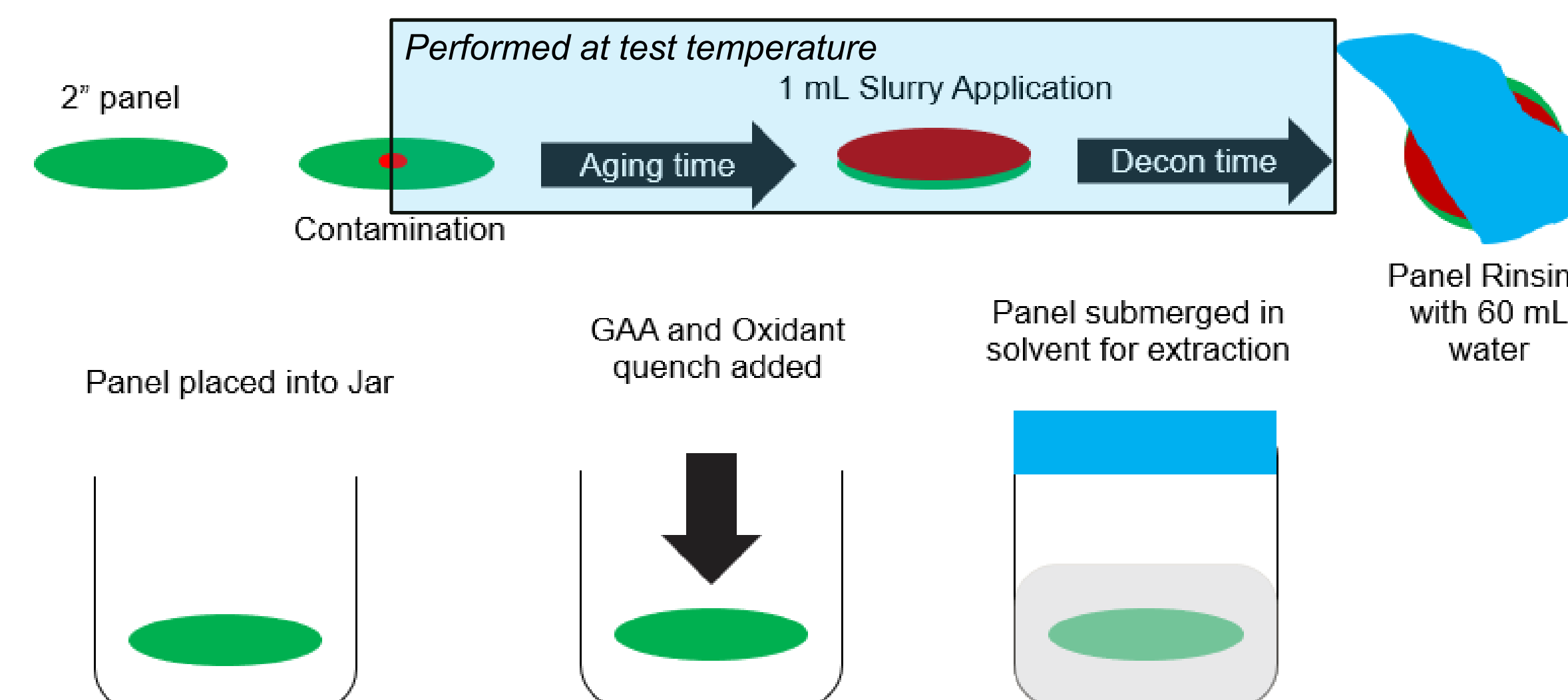
- The rate of detoxification slows
- Decon less effective
- Absorption of the contaminants into substrate slows
- Decon has better access
- Contaminants and aqueous Decontaminants may freeze

TEMPERATURE-CONTROLLED CHAMBER



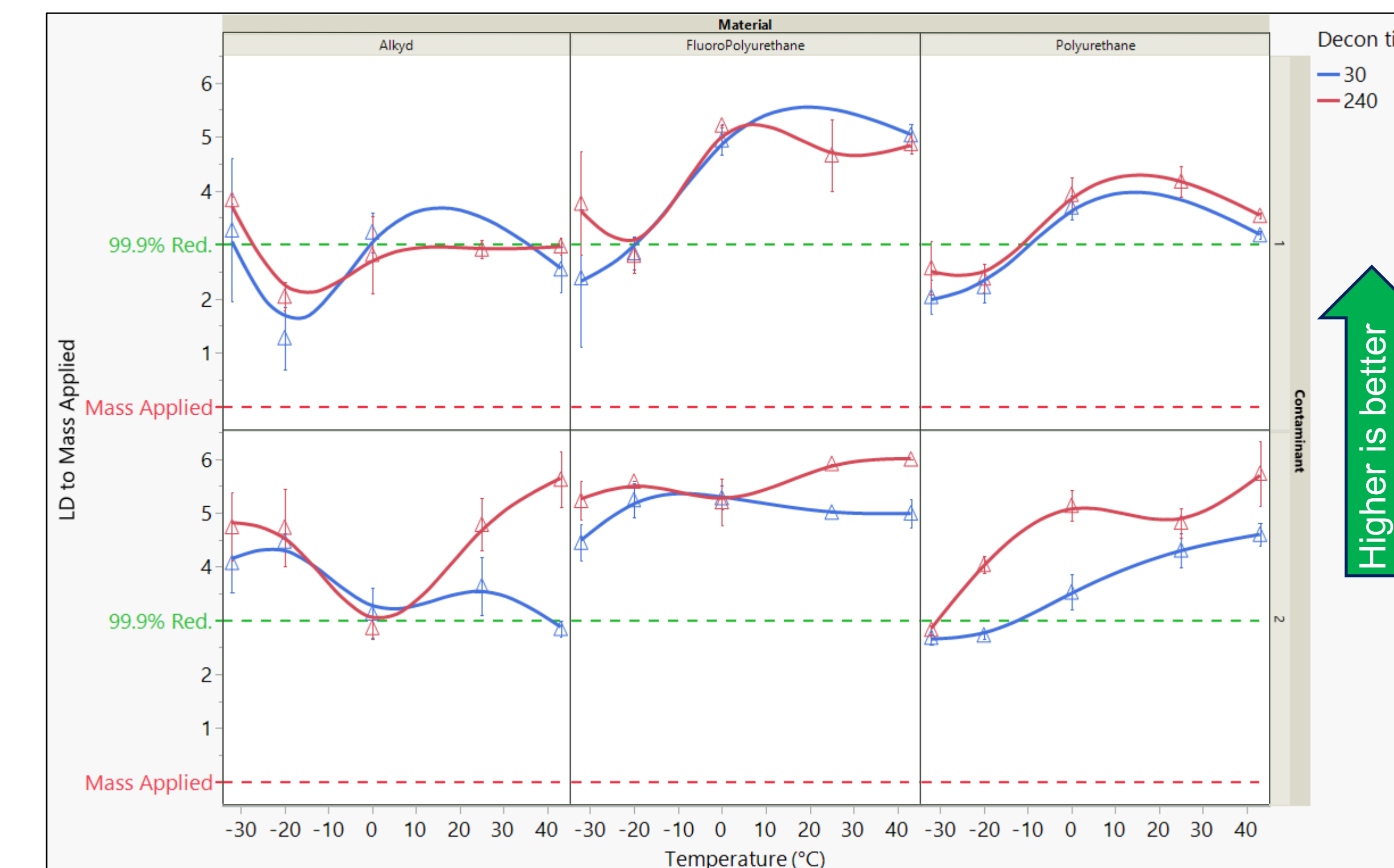
- Custom chamber from Electro-Tech Systems, Perkasi, PA
- Installed inside existing engineering controls
- Approved by DEVCOM CBC Safety and Health Office
- Uses high pressure liquid nitrogen to achieve cold temperatures
- Temperature range: -40° C to 50° C
- Stainless steel bottom tray for containment

PANEL TEST PROCEDURE



Test substrates were preconditioned at test temperature for at least 30 min prior to contamination. Panels were removed from the environmental chamber briefly and were contaminated at room temperature (prevented contaminant freezing). Panels were immediately returned to the environmental chamber for aging, slurry application, and decontamination time. Slurry was applied using a Gilson M1000 pipette, and a 1 mL aliquot was applied to the center of the substrate. An offset spatula was used to spread out the decontaminant over the surface of the substrate. After the decontamination time, the panels were removed from the environmental chamber and the slurry was rinsed off each panel with deionized water. The panels were placed into a glass jar, quenched with glacial acetic acid (GAA) and Tetrahydrothiophene, before being extracted for 60 min in analytical solvent. Samples for contaminant 1 were analyzed by GC/MS and samples for Contaminant 2 were analyzed by LC/MS/MS.

RESULTS AND DISCUSSION



- For *Contaminant 1*, the best efficacy was observed at temperatures above 0° C.
- Decreased efficacy was observed below 0° C, likely due to freezing of the contaminant (reduced interaction).

-For *Contaminant 2*, the efficacy was either at/near or greater than 99.9% reduction over the temp range from -32 to 43° C.

- The 240 min decon time showed higher performance than the 30 min decon time, suggesting an overall slower removal /detoxification rate, particularly at higher temps.

Both contaminants on Alkyd showed trends that deviate from the temperature-reactive proportionality

Decon slurry produced results that were near the target efficacy (99.9%) or exceeded 99.9% reduction for both contaminants across the range of temperatures, with the notable exception of when Contaminant 1 was frozen, reducing the slurry's ability to interact with the droplet.

CONCLUSIONS

- DEVCOM CBC Decontamination Sciences Branch has developed a method for and capability to perform decontamination evaluations over a wide range of temperatures, using source document methodology (TR-980), down to -40° C.
- Chemical reactivity, absorption of liquid contaminants into absorptive substrates, and the interaction of decontaminants with contaminants can be greatly affected by temperature. Decon slurry remained a flowing liquid and could be easily pipetted down to -32° C.
- The slurry removed ~99.9% of Contaminant 1 from all three substrates at temperatures between 0° and 43° C. Efficacy was reduced at lower temperatures, likely due contaminant freezing in the 15 min aging time, reducing the interaction between the slurry and the contaminant.
- The Decon slurry maintained greater than 99.9% reduction against contaminant 2 across the temperature range between -32° C and 43° C. Contaminant 2 did not freeze.

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